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LAPAROSCOPIC PARTIAL NEPHRECTOMY FOR CANCER: TECHNIQUES AND OUTCOMES

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ABSTRACT

Open partial nephrectomy is the gold standard nephron-sparing treatment for small renal tumors. Technical aspects of laparoscopic partial nephrectomy have evolved considerably, and the technique is approaching established status at our institution. Over the past 4 years, the senior author has performed more than 400 laparoscopic partial nephrectomies at the Cleveland Clinic. Herein we present our current technique and review contemporary outcome data.

Key words: kidney neoplasms; laparoscopy; surgery, conservative; partial nephrectomy
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INTRODUCTION

Laparoscopic partial nephrectomy (LPN) was first performed more than 10 years ago (1,2). Since the widespread use of contemporary imaging techniques has resulted in an increased detection of incidental small renal tumors, many centers have published their experiences with LPN (3-9). Initially, small exophytic tumors were selected for LPN. With increasing experience, larger, infiltrating tumors have been submitted to laparoscopic partial nephrectomy (4,5,10). Securing renal parenchymal hemostasis and sutured water-tight caliceal repair after tumor excision is paramount. In an attempt to minimize these technical problems, several new techniques and technologies have recently been explored. Herein we describe our current technique and review the outcomes of laparoscopic partial nephrectomy.

TECHNIQUE

Our laparoscopic technique attempts to duplicate established oncological and reconstructive principles inherent to open partial nephrectomy (10). Selection of the laparoscopic approach depends on tumor location. Posterior or posterolateral tumors are approached retroperitoneoscopically, while anterior, antero-lateral, or lateral tumors are approached transperitoneally. Precise preoperative imaging using three-dimensional computed tomography (CT) with volume-rendered video reconstruction, and real-time intraoperative ultrasonography of the tumor provide the surgeon with detailed information that facilitates the laparoscopic procedure.

All patients undergo cystoscopic placement of a 5F open ended ureteral catheter that is positioned in the renal pelvis. A 60 cc syringe filled with dilute indigo carmine dye is attached to the ureteral catheter. Retrograde injection via this catheter is used to confirm collecting system entry and water-tight closure.

Transperitoneal Approach

Typically, the patient is secured to the table in a 45 to 60-degree lateral position, and a 4 or 5-port transperitoneal approach is employed (Figure-1). The ureter and gonadal vein are identified and retracted laterally. Dissection is carried cephalad along the psoas muscle and the renal hilum is dissected en bloc. Gerota's fascia is dissected off the kidney, preserving the perirenal fat in contact with the tumor. A laparoscopic Satinsky clamp is then positioned for hilar clamping (Figure-1). Attention must be taken not to disrupt any lumbar vessels in the hilum when applying the clamp. Occasionally, small, superficial, completely exophytic tumors may be managed without hilar clamping (11).

Intraoperatively, a laparoscopic flexible ultrasound color Doppler probe is introduced through a 10/12 mm port and positioned in direct contact with the surface of the kidney. Information regarding tumor size, depth of intraparenchymal extension and distance from the collecting system is obtained. The renal capsule is scored circumferentially with J-hook electrocautery under sonographic guidance maintaining an approximate 0.5 cm margin of normal renal parenchyma around the tumor. One to two prepared Surgicel (Johnson & Johnson, New Brunswick, New Jersey) bolsters and a needled suture (#1 Vicryl sutures on a CT-X needle) are introduced into the abdomen through a 12 mm port and positioned lower down in the paracolic gutter. Mannitol (12.5 to 25 mg) and furosemide (10 to 20 mg) are given intravenously. If the warm ischemia time is anticipated to last longer than 30 minutes renal hypothermia is achieved (12).

The severity of renal ischemic injury is directly proportional to the duration of ischemia (13). Clinically, an accepted practice during nephron-sparing surgery has been to limit warm ischemia to ≤ 30 min. Regional hypothermia is often utilized when prolonged times are anticipated. Various methods have been studied to address this issue (12,14,15). At the Cleveland Clinic, regional hypothermia is employed with ice slush only when prolonged ischemic times are anticipated. In addition, adequate hydration and mannitol are administered to optimize renal perfusion and urine output.

The hilum is then clamped and the tumor excised with cold scissors. If achievement of an adequate margin requires entry into the collecting system, the calyx or renal pelvis is divided sharply without electrocautery. (Figure-2). An excisional biopsy of the base is sent for frozen section analysis. The collecting system is closed with a running 2-0 Vicryl on CT-1 needle. Injection of dilute indigo carmine via the preplaced ureteral catheter is performed to confirm watertight closure of the collecting system. Renal parenchymal repair is completed using simple #1-Vicryl sutures on a CT-X needle. Briefly, interrupted sutures are placed over the Surgicel bolster

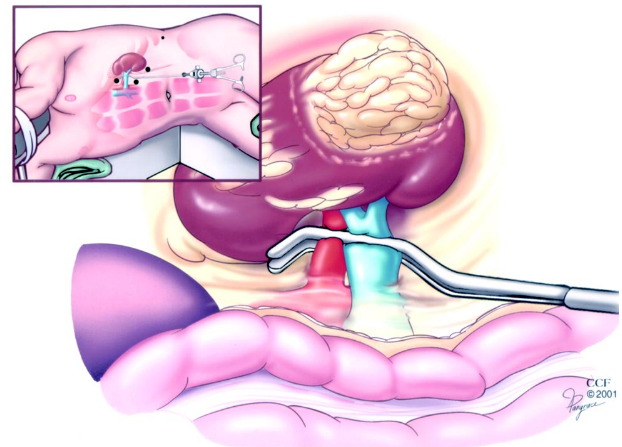

Figure 1 *– Transperitoneal technique of laparoscopic partial nephrectomy. Laparoscopic Satinsky clamp is used to obtain en bloc control of renal hilum. Inset shows port arrangement. Adapted from reference 10. (Reprinted with the permission of the Cleveland Clinic Foundation).*

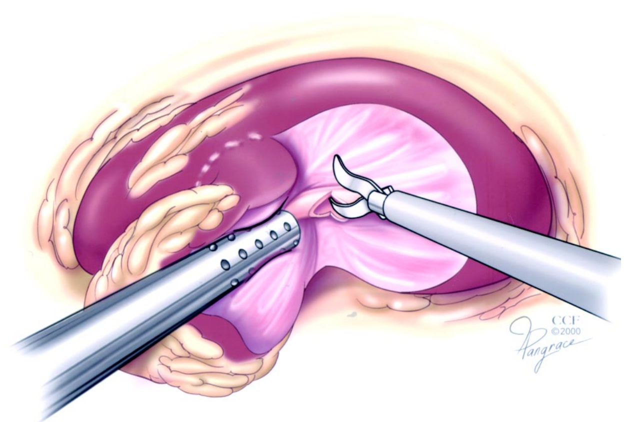

Figure 2 *– Tumor excision. Calyx adjacent to tumor is being deliberately entered sharply with shears to maintain a margin of healthy renal parenchyma. Adapted from reference 10. (Reprinted with the permission of the Cleveland Clinic Foundation).*

(Figure-3), a Hem-o-Lok clip (Weck Closure System, Research Triangle Park, NC) is secured on the suture to prevent it from pulling through, and FloSeal (Baxter, Mountain View, CA) is applied to the cut surface beneath the bolster. The suture is then tied, maintaining adequate compression. One or more sutures are placed depending on the extent of resection. The Satinsky clamp is released and complete hemostasis and renal revascularization is confirmed. The excised tumor is placed in an impermeable sac and extracted through a minimally extended lower abdominal port site incision. A Jackson-Pratt drain is placed in patients where calyceal entry has occurred and laparoscopic exit is performed.

Retroperitoneal Approach

With the retroperitoneal approach, following balloon dilation and placement of 3 (12 mm) ports, the renal artery and vein are dissected to facilitate application of laparoscopic bulldog clamps to each vessel (Figure-4). Recently, we have clamped the hilum en bloc using a Satinsky clamp positioned through a separate (12 mm) trocar. Similar to the transperitoneal approach, the tumor is excised, and renal parenchymal repair and hemostasis are achieved, with caliceal suturing as necessary. The bulldog clamp is removed from the renal vein initially, and then, from the renal artery. Drain placement and exit are performed.

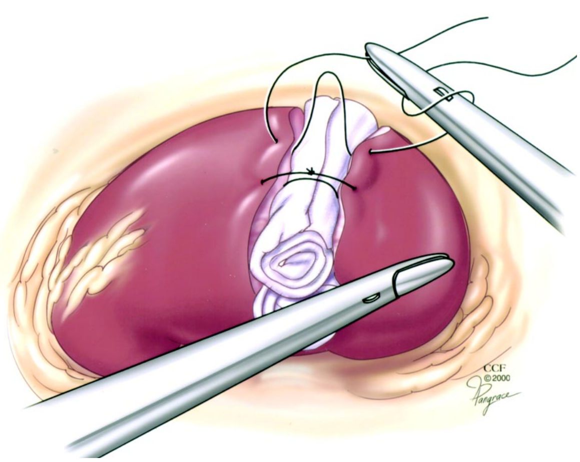

Figure 3 *– Renal parenchymal repair over bolsters. Adapted from reference 10. (Reprinted with the permission of the Cleveland Clinic Foundation).*

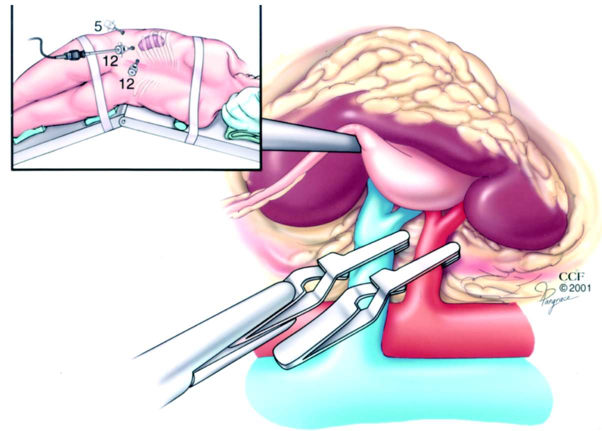

Figure 4 *– Retroperitoneal laparoscopic partial nephrectomy. Because of limited operative space, 2 laparoscopic bulldog clamps are used for individual control of the mobilized renal artery and vein, respectively. Inset shows 3-port retroperitoneal approach. Adapted from reference 10. (Reprinted with the permission of the Cleveland Clinic Foundation).*

RESULTS AND COMMENTS

We have approached more than 350 LPN at our institution. A cohort of 100 patients undergoing laparoscopic partial nephrectomy was compared to a group of 100 patients undergoing open nephron sparing surgery for a sporadic single renal tumor of 7 cm or less at our institution (16). Since our laparoscopic technique was based on our established open surgical principles, the 2 approaches were similar in regards all the steps of partial nephrectomy. The median tumor size was 2.8 cm in the laparoscopic group compared to 3.3 cm in the open group ($p = 0.005$). When comparing the laparoscopic to open groups, the median surgical time was 3 vs. 3.9 h ($p < 0.001$); estimated blood loss was 125 vs. 250 mL ($p < 0.001$); and the mean warm ischemic time was 28 vs. 18 min ($p < 0.001$). The laparoscopic group required less postoperative analgesia and experienced a shorter hospital stay and period of convalescence ($p < 0.001$ for all 3 comparisons). Although there were more intraoperative complications in the laparoscopic group (5% vs. 0), the frequency of postoperative complications was similar (9% vs. 14%; $p = 0.27$). There were 3 positive surgical margins in the laparoscopic group and none in the open group. One of the patients had an oncocytoma and the other 2 had renal cell carcinoma. At 2- and 3-year follow-up, both patients have remained free of disease.

At our institution, Desai et al. (17) recently evaluated the impact of warm ischemic renal hilar occlusion on renal function in 179 patients after laparoscopic partial nephrectomy. Mean duration of warm ischemia for the entire group was 31 minutes (range 4-55 min). The study revealed no significant change in serum creatinine when dividing patients according to duration of warm ischemia, age and or baseline serum creatinine. In patients with a solitary kidney (N = 15), there was a transient rise in serum creatinine in the immediate postoperative period; however, the percent rise in serum creatinine from baseline (mean 1.3%) at latest follow-up (mean 4.8 months) approximated the subjective amount of renal parenchyma excised (mean 29%). Preexisting azotemia and advanced age increased the risk of postoperative kidney dysfunction if warm ischemia time was greater than 30 minutes.

Guillonneau et al. (18) retrospectively performed a comparison of laparoscopic partial nephrectomy with (N = 12) and without (N = 16) renal hilar clamping. Tumor size was larger in the group with renal hilar clamping (2.5 vs. 1.9 cm.). The group without renal hilar clamping was associated with a significantly greater blood loss (708 mL vs. 270 mL, p = 0.014), and longer operative time (179 minutes vs. 121 minutes, p = 0.004) as compared to the group with renal hilar control. There was no significant difference in postoperative serum creatinine (1.26 mg/dL vs. 1.45 mg/dL, p = 0.075) between the groups. They concluded that renal hilum clamping during tumor resection and renorrhaphy seems to be associated with less blood loss and shorter laparoscopic operative times.

In another study (19) we evaluated the outcome of laparoscopic heminephrectomy (defined as excision of ≥ 30% renal parenchyma) in 41 patients with renal tumor and compared outcome data to a contemporary cohort undergoing laparoscopic partial nephrectomy (excision of < 30% renal parenchyma). The laparoscopic heminephrectomy group had larger tumors (4.0 cm vs. 2.4 cm, p < 0.001) with greater intraparenchymal extension (2.3 cm vs. 1.4 cm, p < 0.001). Additionally, laparoscopic heminephrectomy was associated with a longer warm ischemia time (38.7 min. vs. 34.2 min., p = 0.01). There were no significant differences between the 2 groups as regards blood loss (210 mL vs. 172 ml, p = 0.32), intraoperative complications (2.4% vs. 2.4%, p = 1.0), postoperative complications (7.3% vs. 7.3%, p = 1.0), and late complication rate (9.8% vs. 7.3%, p = 0.72).

In an effort to improve hemostasis, the use of ancillary agents has been studied. Our group (20) retrospectively compared outcome data in 131 patients undergoing laparoscopic partial nephrectomy with (N = 63) or without the use of FloSeal (N = 68). Both groups were comparable as regards to tumor size, number of central tumors, performance of pelviocaliceal suture-repair, operative time, duration of warm ischemia, blood loss, and hospital stay. The group using FloSeal had significantly less complications (16% vs. 37%, p = 0.008), and tended towards a lower incidence of hemorrhagic complications (3% vs. 12%, p = 0.08).

CONCLUSION

LPN is an emerging, efficacious treatment option for select patients. We are expanding our indications to include tumors that are larger, deeply infiltrating and present in less technically favorable locations. However, LPN is still a challenging operation that must be performed by surgeons with experience in advanced urologic laparoscopic procedures.

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